2009

Quantifying the role of riparian management to control non-point source pollution of pasture and cropland streams

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Keywords
Animal Science, Economics, Agronomy, Natural Resources Ecology and Management, Animal management and forage, Conservation practices, Water quality quantity and management

Disciplines
Agricultural Economics | Animal Sciences | Natural Resource Economics | Natural Resources and Conservation | Water Resource Management

Lead Investigators
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Budget:
$113,276 for year one
$104,691 for year two
$107,031 for year three

Q Are there options to complete exclusion of cattle for maintaining water quality of pasture streams?

ECOLOGY

A Yes, strategies such as rotational grazing with controlled grazing of the riparian paddock, building of stabilized stream access points, and/or providing off-stream water will reduce the risks of sediment and nutrient loading of pasture streams associated with congregation of cattle in or near pasture streams.

Background

Because of its association with eutrophication of rivers and lakes, phosphorus loading of surface water sources is a major non-point source pollution problem in Iowa. Since much of the phosphorus in soil is adsorbed to soil particles, soil erosion promotes phosphorus pollution of surface water sources. Overgrazing along pasture streams also may result in soil erosion, but little research has evaluated the effects of grazing management on sediment and phosphorus loading of pasture streams in the Midwest. Improved management practices to reduce sediment and phosphorus movement from stream banks and riparian areas need to be demonstrated.

Objectives were to:

- Quantify losses of sediment and phosphorus (P) from stream banks in pastures grazed under different stocking systems in one location to control animal management and minimize differences in factors such as stream flow and structure, soil chemical and physical structure and riparian and upland pasture vegetation.
- Measure the spatial and temporal distribution patterns of location, defecation and urination of beef cattle managed in different stocking systems in pastures with upland and riparian zones.
- Demonstrate site-specific models of grazing management practices that optimize the quality of stream water and the profitability of beef cow-calf production in pastures in Iowa.

Approach and methods

A three-year grazing study, initiated in spring 2004, was conducted at the Iowa State University Rhodes Research Farm in central Iowa. The study sought to demonstrate the effects of continuous stocking of cattle having unrestricted stream access (CSU), continuous stocking of cattle with stream access restricted to a reinforced crossing with the remainder of the riparian area fenced to prevent cattle access (CSR), and rotational stocking with grazing of the riparian paddock limited to a maximum of four days or a minimum forage sward height of 4 inches (RS).

Jim Russell presenting stream bank erosion data at the Rhodes Farm Field Day, October 2006.

Results and discussion

Over the three years of the demonstration, stream bank erosion and channel morphology were measured, as were the occurrence of bare and fecal-covered ground and forage sward height and mass in the riparian and upland portions of the pasture. Cattle distribution patterns also were monitored monthly during the grazing seasons to determine the proportion of time the cattle spent in the stream and riparian areas of pastures.

Stream bank erosion susceptibility scores were greater in CSU pastures than in CSR or RS pastures during the 2006 and 2007 grazing seasons. Even though stream banks in CSU pastures were more susceptible to erosion than were stream banks in CSR and RS pastures, no difference in stream bank erosion was observed between grazing management practices in any year studied. Annual net stream bank erosion averaged -2.13 (erosion), 0.03 (deposition), and 2.57 (erosion) inches across all treatments in 2005, 2006, and 2007, respectively, resulting in 92, 7.8 and 20 pounds of phosphorus loss per year, respectively.

No differences were observed between grazing management practices in the proportion of bare ground on stream banks except in September and October 2007, when CSU pastures had a greater proportion of bare ground on their banks than did CSR pastures. Forage mass along stream banks and within 110 feet of streams did not differ between CSR and RS pastures during most months, while CSU pastures had or tended to have lower forage masses than did CSR pastures in several months.

Over three grazing seasons, cattle were in or within 110 feet of the stream an average of 6 and 16 percent of the time, respectively, in CSU pastures, based on visual observations. Based on results from GPS collars, cattle were in or within 110 feet of the stream an average of 1.2 and 10.6 percent of the time, respectively, in CSU pastures. Based on visual observation and GPS collars, the proportion of time cattle in CSR and RS pastures were present in and within 110 feet of the streams were less than CSU pastures. The presence of off-stream water decreased the proportion of time cattle spent in the streams during the 2006 grazing season, but not in 2005 or 2007.

Conclusions

When cattle were allowed unrestricted access to a pasture stream, they averaged 1.3 percent of the time within the stream and 8.8 percent within the riparian area (part of the pasture area).

Restricting access to pasture streams to stabilized crossings or use of rotational grazing with limited grazing of riparian paddocks will reduce the proportion of time grazing cattle are found in or near pasture streams.

By altering cattle distribution, restricting access of grazing cattle to stabilized crossings or rotational grazing will reduce the potential for sediment and phosphorus loading of pasture streams. This was shown by greater forage masses and sward

Cow fitted with an AgTrax (BlueSky Telemetry) GPS collar during 2006 grazing season.

heights and lower proportions of bare and manure-covered ground on and/or near pasture stream banks compared to continuous stocking of grazing cattle with unrestricted access to pasture streams.

Because net erosion and soil erosion-deposition activity did not differ between grazing treatments and there were no month-by-month treatment interactions for erosion susceptibility scores or stream channel morphology, the effects of natural variation in stream bank erosion were greater than any effects of grazing over three years.

Impact of results

Although other studies have implicated cattle grazing as a major contributor to sediment and phosphorus loading of pasture streams, this study found no difference in sediment or phosphorus loading resulting from stream bank erosion in pastures grazed by continuous stocking with either unrestricted or restricted access or rotational stocking. Thus, hydrologic processes seem more responsible for bank erosion in pasture streams than grazing management. The average amount of phosphorus lost by stream bank erosion was 39.8 lb over the 462 feet of stream reach in each pasture across treatments.

This study did find that the distribution of manure deposition was directly related to the temporal/spatial distribution of grazing cattle. Therefore, use of stabilized crossings, off-stream water, or rotational stocking will reduce the risks of nutrient loading associated with grazing cattle. In pastures in which cattle had unrestricted stream access, 0.63 and 5.83 gm phosphorus/cow/day were excreted in and within 110 feet of the stream. Use of stabilized crossings, off-stream water, and rotational stocking reduced the congregation of cattle near streams, the use of stabilized crossings or off-stream water reduced the amounts of phosphorus excreted into the stream by 87 and 37 percent. Use of stabilized crossings, off-stream water, or rotational stocking reduced the amounts of phosphorus excreted within 110 feet of the stream by 84, 31, and 47 percent, respectively.

Education and outreach

Eight ISU Animal Industry reports were prepared based on the project. See www.ans.iastate.edu/report/air/ More information on the project appears at www.iowabeefcenter.org/content/RhodesStreamBankProjectIntro.pdf

Presentations on the project were made at 27 conferences. Among them were the ASA-CSSA-SSSA annual meeting, the Iowa Forage and Grassland Conference, the National Conference on Grazing Lands, Iowa Watersheds Annual Meeting, American Forage and Grasslands Conference, American Society of Animal Science-American Society of Dairy Science Annual Meeting, and USDA Grazing Behavior Workshop.

Five field days featuring the project were held at the ISU Rhodes Research farm between 2004 and 2007. Two 2007 field day events at the McNay Research Farm discussed grazing management of beef related to the project work.

Stream banks in rotational stocking pasture following two days of occupation (September 2006).

The information from the project also was the basis of three publications: "A Guide to Managing Pasture Water: Stabilized Stream and Pond Access Sites" (IBC08-2), "A Guide to Managing Pasture Water:Streamside Buffer (IBC08-3)", and "A Guide to Managing Pasture Water: Off-stream Water, Shade, and Nutritional Supplementation to Modify Animal Behavior (IBC08-4)" (View them at http://www.iowabeefcenter.org/content/research_projects.html)

Leveraged funds

Additional funding came from two other granting agencies:

- Pasture management effects on non-point source pollution of Midwestern watersheds, USDA-CSREES National Integrated Water Quality Program 406, $598,461
- Grazing management effects on pathogen loading of Midwestern pasture streams, USDA-CSREES NRI, $399,770

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